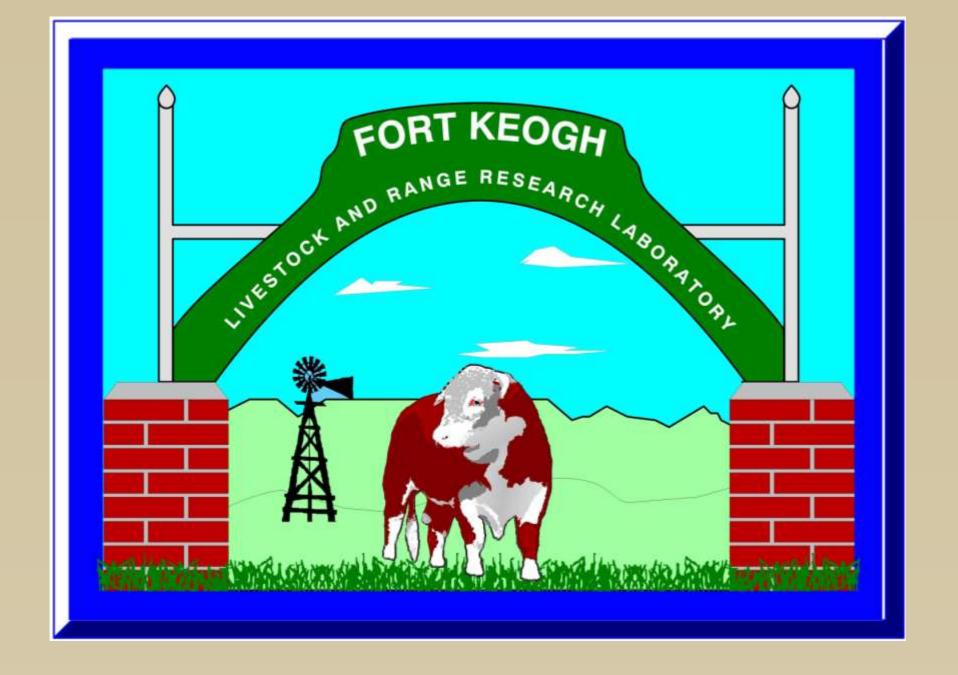


# Understanding priority effects may help improve restoration outcomes and establishment of *Artemisia tridentata* spp. wyomingensis

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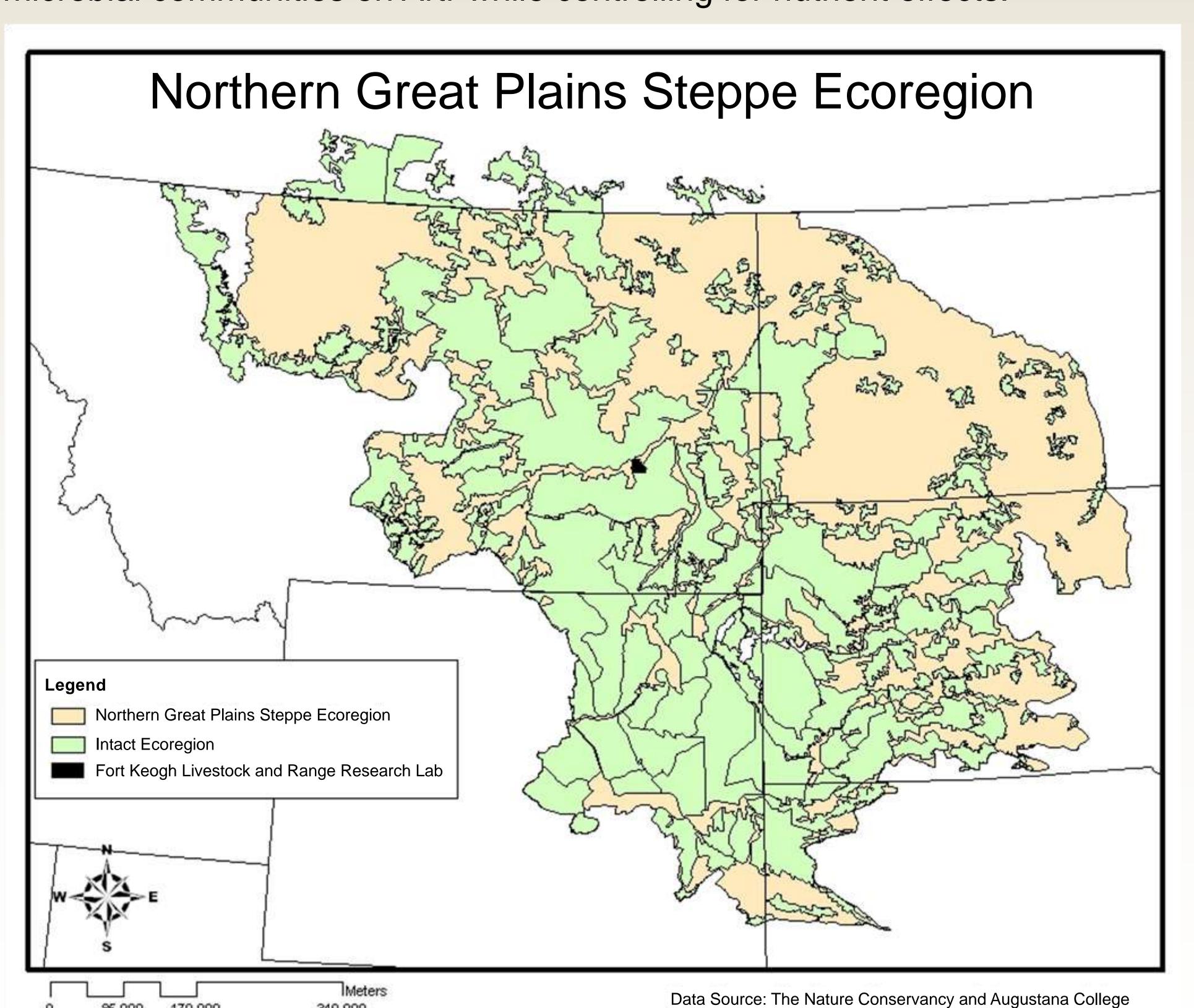
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### Introduction

Summer droughts act as a major environmental filter negatively affecting the establishment of plants in arid and semiarid environments. **Priority effects**, where an earlier growing species affects the establishment, growth, and reproduction of a later growing species, may have lasting effects on the dominance of the system and should be considered when developing restoration plans. An understanding of priority effects may permit managers to use staged seeding/planting strategies to improve establishment rates of critical species.

Here we explore the topic of priority effects in the context of sagebrush restoration, a major concern for agencies attempting to restore degraded sagebrush habitat. Specifically, we explore the effect of soil pre-conditioning (i.e., **soil legacies**- one mechanism driving priority effects) by nine to ten mixed-grass prairie species on growth of *Artemisia tridentata* spp. *wyomingensis* (abbrev. Artr). This is done by using a plant legacy experiment designed to detect effects of plant-driven changes in soil microbial communities on Artr while controlling for nutrient effects.



Northern Great Plains Steppe Ecoregion. Over 53 million acres of large intact mixed-grass prairie persist in this portion of the Great Plains. Fort Keogh Livestock and Range Research Laboratory, located in southeastern Montana, is centrally located in this region.

## Methods

Soil was collected from two loamy sites (Custer L pasture and Upper Coal Creek pasture) on Fort Keogh. The area receives an average of 342 mm of precipitation per year. The collected soil was homogenized and then used in a plant legacy experiment.

A two part plant legacy experiment (a modification of soil feedback experiments) was conducted in 2009 through 2010. The experiment consisted of a conditioning stage that was planted with 9 or 10 species per site. Soil from the conditioning stage was then used to inoculate the final portion of the experiment which compared the growth of Artr in pots inoculated with soil conditioned by each species individually vs. a composite mixture of inocula from either 9 or 10 species per site. A soil legacy effect was quantified by comparing the shoot biomass of Artr in pots with soil conditioned by individual species vs. the composite.

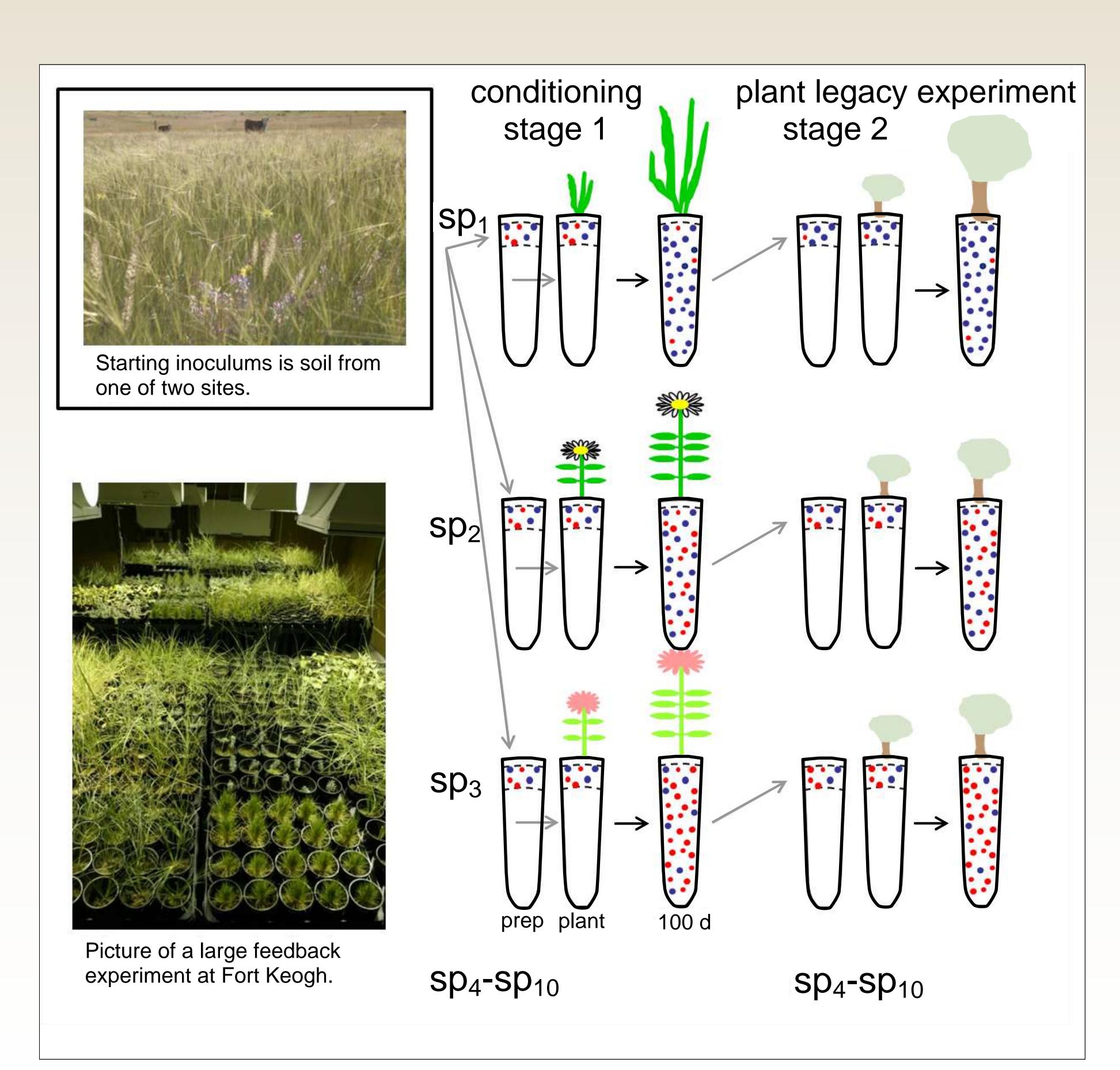


Illustration of the two part plant legacy experiment. Arrows illustrate the development of the experiment. Each plant species treatment (sp1, sp2, etc.) had eight replicates. Colored dots in the "conetainers" depict the microbial life in the soil and possible shifts in composition over time.



Photograph taken at Fort Keogh showing shrub-steppe landscape of mixed-grass prairie and Artemisia tridentata spp. wyomingensis (Artr)

#### Results

#### Figure Legend

Results from the soil legacy experiment. Bars represent mean soil legacy effect comparing growth of Artr in soil of specific species versus a composite of the 9 or 10 species per site. Values greater than zero indicate cases of positive feedbacks where Artr grew more in pots inoculated with soil from an individual species than the composite. Means and 95% CI are derived from a bootstrapping procedure. Green bars indicate significant positive feedback effects (P< 0.05). This indicates that Artr growth was enhanced when grown in soils with a legacy of individual species (e.g., Arfr, Koma, and Spco) compared to growth in pots inoculated with a composite inocula. Red bars indicate significant negative feedback effects.

Ardr- *Artemisia dracunculus* (green sagewort) Arfr- *Artemisia frigida* (fringed or prairie sagewort)

Artr- *Artemisia tridentata* spp. *wyomingensis* (Wyoming big sagebrush)

Bogr- Bouteloua gracilis (blue grama)
Brja- Bromus japonicus (Japanese brome)
Heco- Hesperostipa comata (needle-and-thread)

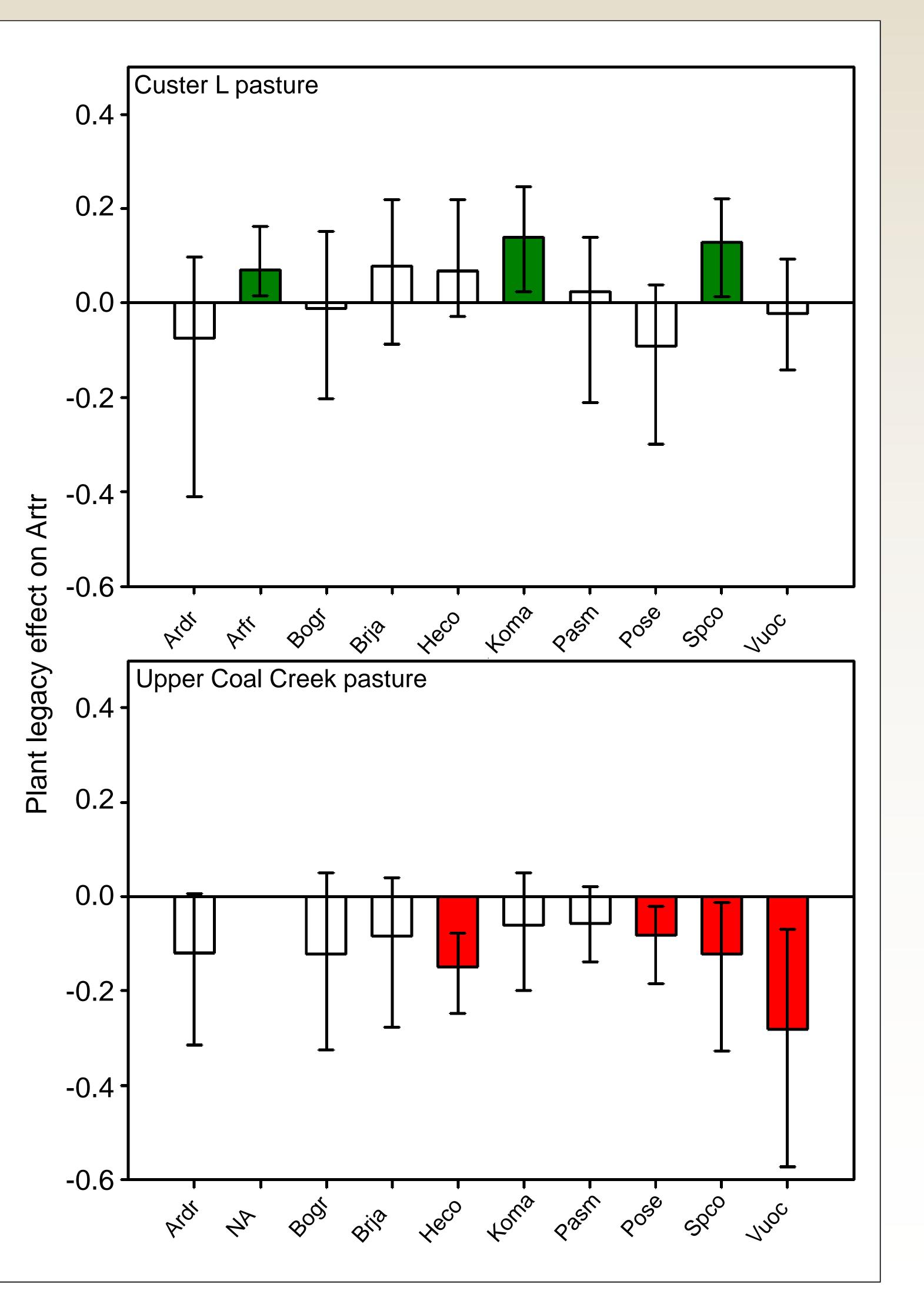
Koma- Koeleria macrantha (prairie

junegrass)

Pasm- *Pascopyrum smithii* (western wheatgrass)

Pose- *Poa secunda* (sandberg bluegrass) Spco- *Sphaeralcea coccinea* (scarlet globemallow)

Vuoc- *Vulpia octoflora* (sixweeks fescue)



- Study revealed variation among sites probably because of varying microbial communities at each site
- 3 of 10 species (green bars) at the Custer L pasture on Fort Keogh had positive plant legacy effects on *Artemisia tridentata* spp. *wyomingensis* (Artr). In contrast, two species (*Artemisia dracunculus* [Ardr] and *Poa secunda* [Pose]) tended to have negative legacy effects.
- Soil from Upper Coal Creek pasture conditioned by individual plant species tended to have negative legacy effects on Artr compared to the composite soil treatment. 4 of 9 species (red bars) had significant negative legacy effects on Artr growth.
- Across both sites, *Koeleria macrantha* (Koma) tended to have the most positive soil legacy effect on Artr. Spco had varying legacy effects ranging from positive at one site to negative at the other. Pose and Ardr tended to have negative legacy effects on Artr.

# Summary

- While preliminary in nature, these results illustrate how soil microbes may drive soil legacy and priority effects. Several species exhibited relatively consistent positive (Koma) and negative legacy effects (Pose and Ardr) on Artr.
- Improved understanding of legacy effects and plant-plant facilitation is likely to improve restoration practices especially in semiarid regions where establishment rates are often low.